T15D15 – 2011 IB HL Energetics Exam (FOR REVIEW)

Name……..

1. Which reaction causes a decrease in the entropy of the system?

A. $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

B. $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

C. $2C(s) + O_2(g) \rightarrow 2CO(g)$

D. $2SO_3(g) \rightarrow 2SO_2(g) + O_2(g)$

2. The $\Delta H^{\ominus}$ and $\Delta S^{\ominus}$ values for a reaction are both negative. What will happen to the spontaneity of this reaction as the temperature is increased?

A. The reaction will become more spontaneous as the temperature is increased.

B. The reaction will become less spontaneous as the temperature is increased.

C. The reaction will remain spontaneous at all temperatures.

D. The reaction will remain non-spontaneous at any temperature.

3. Which type of reaction is referred to in the definition of *standard enthalpy change of formation*?

A. the formation of a compound from its elements

B. the formation of a crystal from its ions

C. the formation of a molecule from its atoms

D. the formation of a compound from other compounds

4. Which equation represents the lattice enthalpy of magnesium oxide?

A. $Mg(s) + \frac{1}{2} O_2(g) \rightarrow MgO(s)$

B. $Mg^{2+}(g) + O^{2-}(g) \rightarrow MgO(g)$

C. $Mg^{2+}(g) + \frac{1}{2} O_2(g) \rightarrow MgO(s)$

D. $Mg^{2+}(g) + O^{2-}(g) \rightarrow MgO(s)$

7. (a) Define the term *standard enthalpy change of formation*, $\Delta H_f^{\ominus}$.

(2)

(b) (i) Use the information in the following table to calculate the enthalpy change for the complete combustion of but-1-ene according to the following equation.

$C_4H_8(g) + 6O_2(g) \rightarrow 4CO_2(g) + 4H_2O(g)$

Compound	$C_4H_8(g)$	$CO_2(g)$	$H_2O(g)$
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	+ 1	– 394	– 242

(3)

(ii) Deduce, giving a reason, whether the reactants or the products are more stable.

(2)

(iii) Predict, giving a reason, how the enthalpy change for the complete combustion of but-2-ene would compare with that of but-1-ene based on average bond enthalpies.

(1)

(Total 8 marks)

9. The standard enthalpy change for the combustion of phenol, $C_6H_5OH(s)$, is –3050 kJ mol^{-1} at 298 K.

(a) Write an equation for the complete combustion of phenol.

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(1)

(b) The standard enthalpy changes of formation of carbon dioxide, $CO_2(g)$, and of water, $H_2O(l)$, are –394 kJ mol^{-1} and –286 kJ mol^{-1} respectively.
Calculate the standard enthalpy change of formation of phenol, $C_6H_5OH(s)$.

(3)

(c) The standard entropy change of formation, $\Delta S^{\ominus}$, of phenol, $C_6H_5OH(s)$ at 298 K is –385 J K^{-1} mol^{-1}. Calculate the standard free energy change of formation, $\Delta G^{\ominus}$, of phenol at 298 K.

(3)

(d) Determine whether the reaction is spontaneous at 298 K, and give a reason.

(2)

(e) Predict the effect, if any, of an increase in temperature on the spontaneity of this reaction.

(2)
(Total 11 marks)

T05D08 – IB SL Energetics Exam

Name……

1. The following equations show the oxidation of carbon and carbon monoxide to carbon dioxide.

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H^{\ominus} = -x \text{ kJ mol}^{-1}$$

$$CO(g) + \tfrac{1}{2} O_2(g) \rightarrow CO_2(g) \qquad \Delta H^{\ominus} = -y \text{ kJ mol}^{-1}$$

What is the enthalpy change, in kJ mol^{-1}, for the oxidation of carbon to carbon monoxide?

$$C(s) + \tfrac{1}{2} O_2(g) \rightarrow CO(g)$$

A. $x + y$
B. $-x - y$
C. $y - x$
D. $x - y$

2. What energy changes occur when chemical bonds are formed and broken?
A. Energy is absorbed when bonds are formed and when they are broken.
B. Energy is released when bonds are formed and when they are broken.
C. Energy is absorbed when bonds are formed and released when they are broken.
D. Energy is released when bonds are formed and absorbed when they are broken.

3. The $\Delta H^{\ominus}$ values for the formation of two oxides of nitrogen are given below.

$\frac{1}{2}N_2(g) + O_2(g) \rightarrow NO_2(g)$ $\Delta H^{\ominus} = -57$ kJ mol^{-1}

$N_2(g) + 2O_2(g) \rightarrow N_2O_4(g)$ $\Delta H^{\ominus} = +9$ kJ mol^{-1}

Use these values to calculate $\Delta H^{\ominus}$ for the following reaction (in kJ):

$2NO_2(g) \rightarrow N_2O_4(g)$

A. –105
B. – 48
C. +66
D. +123

4. For the reaction

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

the bond enthalpies (in kJ mol^{-1}) are

H–H	*x*
O=O	*y*
O–H	*z*

Which calculation will give the value, in kJ mol^{-1}, of $\Delta H^{\ominus}$ for the reaction?

A. $2x + y - 2z$
B. $4z - 2x - y$
C. $2x + y - 4z$
D. $2z - 2x - y$

5. Which statement is correct about the reaction shown?

$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$ $\Delta H = -196$ kJ

A. 196 kJ of energy are released for every mole of $SO_2(g)$ reacted.
B. 196 kJ of energy are absorbed for every mole of $SO_2(g)$ reacted.
C. 98 kJ of energy are released for every mole of $SO_2(g)$ reacted.
D. 98 kJ of energy are absorbed for every mole of $SO_2(g)$ reacted.

6. Which statement about bond enthalpies is correct?

A. Bond enthalpies have positive values for strong bonds and negative values for weak bonds.
B. Bond enthalpy values are greater for ionic bonds than for covalent bonds.
C. Bond breaking is endothermic and bond making is exothermic.
D. The carbon–carbon bond enthalpy values are the same in ethane and ethene.

7. Which statement is correct for an endothermic reaction?

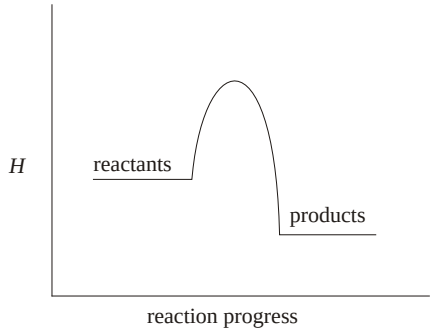
A. The products are more stable than the reactants and ΔH is positive.
B. The products are less stable than the reactants and ΔH is negative.
C. The reactants are more stable than the products and ΔH is positive.
D. The reactants are less stable than the products and ΔH is negative.

8. Which combination is correct for a chemical reaction that absorbs heat from the surroundings?

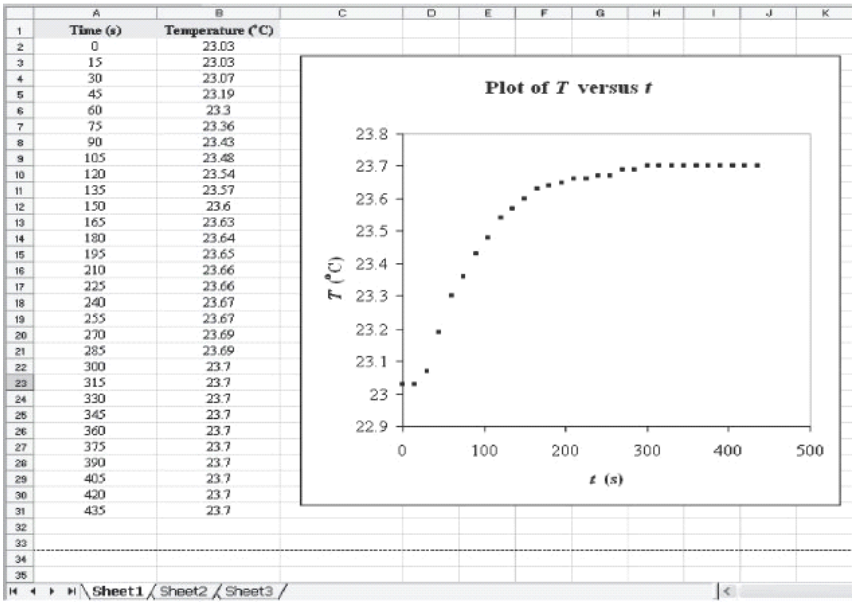
	Type of reaction	**ΔH at constant pressure**
A.	Exothermic	Positive
B.	Exothermic	Negative
C.	Endothermic	Positive
D.	Endothermic	Negative

9. According to the enthalpy level diagram below, what is the sign for ΔH and what term is used to refer to the reaction?

	ΔH	reaction
A.	positive	endothermic
B.	negative	exothermic
C.	positive	exothermic
D.	negative	endothermic



25. The data below is from an experiment used to measure the enthalpy change for the combustion of 1 mole of sucrose (common table sugar), $C_{12}H_{22}O_{11}(s)$. The time-temperature data was taken from a data-logging software programme.



Time (s)	Temperature (°C)
0	23.03
15	23.03
30	23.07
45	23.19
60	23.3
75	23.36
90	23.43
105	23.48
120	23.54
135	23.57
150	23.6
165	23.63
180	23.64
195	23.65
210	23.66
225	23.66
240	23.67
255	23.67
270	23.69
285	23.69
300	23.7
315	23.7
330	23.7
345	23.7
360	23.7
375	23.7
390	23.7
405	23.7
420	23.7
435	23.7

Mass of sample of sucrose, m = 0.4385 g

Heat capacity of the system, C_{system} = 10.114 kJ K^{-1}

(a) Calculate ΔT, for the water, surrounding the chamber in the calorimeter.

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(1)

(b) Determine the amount, in moles, of sucrose.

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(1)

(c) (i) Calculate the enthalpy change for the combustion of 1 mole of sucrose.

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(1)

(ii) Using Table 12 of the Data Booklet, calculate the percentage experimental error based on the data used in this experiment.

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(1)

(d) A hypothesis is suggested that TNT, 2-methyl-1,3,5-trinitrobenzene, is a powerful explosive because it has:

- a large enthalpy of combustion
- a high reaction rate
- a large volume of gas generated upon combustion

Use your answer in part (c)(i) and the following data to evaluate this hypothesis:

	Equation for combustion	**Relative rate of combustion**	**Enthalpy of combustion / kJ mol^{-1}**
Sucrose	$C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(g)$	Low	
TNT	$2C_7H_5N_3O_6(s) \rightarrow 7CO(g) + 7C(s) + 5H_2O(g) + 3N_2(g)$	High	3406

(3)

(Total 7 marks)

28. Calculate the enthalpy change, ΔH_4 for the reaction

$$C + 2H_2 + \tfrac{1}{2} O_2 \rightarrow CH_3OH \qquad \Delta H_4$$

using Hess's Law and the following information.

$$CH_3OH + 1\tfrac{1}{2} O_2 \rightarrow CO_2 + 2H_2O \qquad \Delta H_1 = -676 \text{ kJ mol}^{-1}$$

$$C + O_2 \rightarrow CO_2 \qquad \Delta H_2 = -394 \text{ kJ mol}^{-1}$$

$$H_2 + \tfrac{1}{2} O_2 \rightarrow H_2O \qquad \Delta H_3 = -242 \text{ kJ mol}^{-1}$$

(Total 4 marks)

29. (a) Define the term *average bond enthalpy*.

(2)

(b) Use the information from Table 10 in the Data Booklet to calculate the enthalpy change for the complete combustion of but-1-ene (CH_2=$CHCH_2CH_3$) according to the following equation

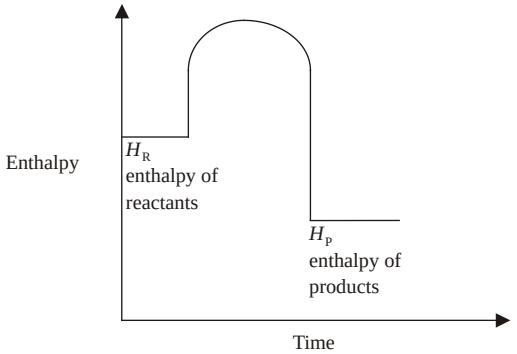
$$C_4H_8(g) + 6O_2(g) \rightarrow 4CO_2(g) + 4H_2O(g)$$

(3)

(c) Predict, giving a reason, how the enthalpy change for the complete combustion of but-2-ene (CH_3CH=$CHCH_3$) would compare with that of but-1-ene (CH_2=$CHCH_2CH_3$) based on average bond enthalpies.

(1)

(d) The enthalpy level diagram for a certain reaction is shown below.



State and explain the relative stabilities of the reactants and products.

(2)

(Total 8 marks)